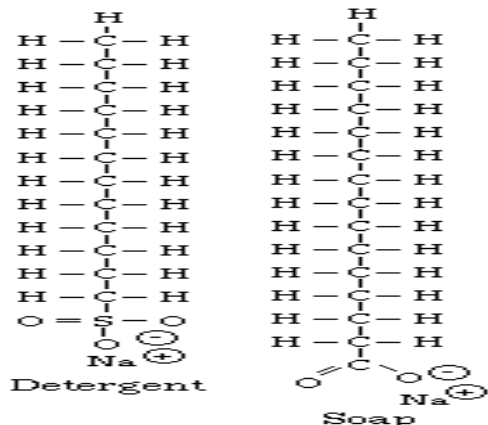


Hard and Soft Water Lab

Introduction/Theory



Water that contains calcium ions, Ca^{2+} , and magnesium ions,

Mg^{2+} , is said to be hard water. These ions are leached from ground water flowing over rock formations containing limestone and other minerals. Hard water interferes with the cleaning action of soaps.

When soap is added to hard water, insoluble compounds form which appear as sticky scum. This scum leaves a deposit on clothes, skin, and hair. You could have ring around the collar!

When boiled, hard water leaves a deposit of calcium carbonate, CaCO_3 . This scale builds up in tea kettles and inside hot water heaters.

Detergents have replaced soap for many cleaning jobs around the home.

The development of synthetic detergents by chemists was a great advantage for people with relatively hard tap water in their homes.

Do you know whether the tap water used in your home is soft or hard? How could you test it to find out? Why do you use detergents for many household cleaning jobs? These are some of the questions you will be able to answer after completing this laboratory investigation.

Purpose

To investigate the chemical action of soap vs. detergents in hard water and the use of a precipitation

Procedure:

Part I: Soap vs. Detergent in Hard Water

1. Add 100 mL of distilled (soft) water to a 250 mL beaker. Then add 2.0 g of magnesium sulfate, MgSO_4 , and stir. Label this beaker hard water. You now have prepared a stock solution of hard water.
2. Arrange three test tubes in a test-tube rack. Half-fill the first test tube with distilled water (soft water). Half-fill the second tube with tap water. Half-fill the third with hard water from the stock solution.
3. Using a metal spatula, add a pea-sized sample of solid soap from a bar of commercial hand soap to each of the three test tubes. (Caution: Remember after shaking several times to stop, release the pressure, re-stopper, and shake.) Stopper and shake the first test tube. Ten shakes is adequate. In your data section, record the height of suds in the test tube as measured with a centimeter scale. Draw a picture of the test tube; record all your observations in the picture.
4. Repeat Step 3 for the other two test tubes. Shake each test tube in an identical manner.
5. Dump and rinse the test tube containing the soap.
6. Repeat Steps 2 and 3, but use a pea-sized sample of a commercial detergent instead of the soap.
7. Dump and rinse the test tubes containing the detergent.

- Repeat Steps 2 and 3 using 20 drops (approximately 1.0 mL) of a commercial hair shampoo in each of the three water samples.
- Dump and rinse the test tubes containing the shampoo.

Part II: Emulsifying Test

- Place four test tubes in a test-tube rack. Half-fill each with hard water.
- Add 3.0 mL of cooking oil to each of the four tubes.
- Add nothing to Tube 1, add a pea-sized sample of hand soap to Tube 2, a pea-sized sample of detergent to Tube 3, and 20 drops of shampoo to Tube 4.
- Stopper and shake all tubes in an identical manner. Return the tubes to the test tube rack.
- On your data sheet draw a picture of the four test tubes; record all your observations in the picture.
- Dump and wash out the test tubes as directed by your teacher.

Part III: Softening Hard Water by Precipitation

- Obtain a 2.0 g sample of sodium carbonate, Na_2CO_3 . Add it to the hard water remaining in the 250 mL beaker.
- Place the beaker and contents on a hot plate. Heat and stir for 5 min.
- Remove the beaker and allow it to cool.
- When the beaker is cool enough to handle, separate the solid precipitate from the liquid using a filtering apparatus or centrifuge, as directed by your teacher.
- Half-fill a clean test tube with the clear filtrate. Add a pea-sized sample of solid hand soap to the test tube, stopper, and shake.
- Record your observations.
- Dispose of the filter paper and solid as directed by your teacher.
- Clean up your bench area and return all materials to their proper places.

Data Table: Make one to collection observations for each Part.

Data Analysis:

- Name the cation and anion added to the distilled water in Part I.
- Which ion is responsible for creating hard water in this activity? Support your answer with observations you recorded throughout the activity and those demonstrated in class.
- Did the hard water look different than the soft water?
- Based on your data, does soap work better in soft or hard water?
- Based on your observations, which works better in hard water -- soap or detergent?
- From your data, would you conclude that shampoo is more like a soap or a detergent? Explain
According to this investigation, would the tap water used be classified as soft or hard water? Justify

Resources: Site these completely. Use easybib.com for help.

Discussion/Conclusion:

- Why don't soaps create suds in hard water?
- Why do you think detergents create suds in hard water, while soaps don't?
- Do you have a water softener in your home?
- How could you test the tap water in your home to decide whether you would benefit from a water softener?
- What do you think are some advantages and disadvantages of having a water softener?
- How do you think a water softener works?